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Rubber Research Scheme (Ceylon)

Fourth Quarterly Circular for 1936.

December, 1936.

H. W. CAVE & CO., COLOMBO.

Rubber Research Scheme (Ceylon).

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REGISTRATION FOR PUBLICATIONS OF THE RUBBER RESEARCH SCHEME (CEYLON.)

Bulletins, Quarterly Circulars and Leaflets published by the Rubber Research Scheme are issued without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of Rubber Estates in Ceylon who apply for their names to be registered for the purpose. Registration must be renewed at the beginning of each year.

Application for registration for 1937 should be made on the attached form and forwarded to:—

The Director,
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Dartonfield, Agalawatta.

Registration for Publications of the Rubber Research Scheme (Ceylon.)

To

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Please register my name for issue of publications of the Rubber Research Scheme (Ceylon) during 1937.

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Name .....

Address .....

.....

Date .....

(Valid from 1st January)

NOTICES.

DARTONFIELD ESTATE—VISITORS' DAYS

The *second* and *fourth* Wednesdays in each month have been set aside as Visitors' Days at Dartonfield Estate, and the services of all Technical Officers will be available to visitors on those days. The Estate Superintendent will be available every Wednesday. Visitors are requested to arrive on the Estate not later than 9-30 a.m.

While visitors will be welcomed at the Station on other days, any particular member of the Staff may not be free to give them attention unless an appointment has been made.

Dartonfield Estate is situated about $3\frac{1}{2}$ miles from the main Matugama-Agalawatta Road, the turn-off being near culvert No. 14/10. The distance from Colombo is approximately 47 miles.

IDENTIFICATION OF CLONES

The attention of Proprietors and Superintendents undertaking replanting or budgrafting programmes is drawn to Planting Manual No. 5: "The History and Description of Clones of *Hevea Braziliensis*" issued by the Rubber Research Institute of Malaya, copies of which may be purchased on application to these Laboratories for Rs. 5-00 each (postage free.) This publication gives drawings and descriptive particulars of the more important clones, which should enable Superintendents to verify the authenticity of their material.

CONTENTS

ORIGINAL ARTICLES

SELECTED ARTICLE

REVIEWS

MEETINGS ETC.

FIELD EXPERIMENTS ON DARTONFIELD ESTATE IV.—REPLANTING 1936.

C. A. DE SILVA,
ASSISTANT BOTANIST

FOREWORD

THE possibility of asking a number of questions from a single experiment is restricted both by the area of land available and the statistical layout of plots and blocks; the latter tending to become more complicated as the number of questions asked increases within a single experiment. This experiment has been designed to include comparisons of alternative methods of opening the land, establishing the new stand, and the effect of organic and inorganic mixtures.

SITE OF EXPERIMENT

The area replanted is approximately 10 acres in extent and is situated in Field No. 1 on the left of the main approach road to Dartonfield. The gradient of the land is moderate generally, but is fairly steep towards the southern boundary; the latter feature is rather to be desired in this case, especially in testing out methods of opening.

DESIGN AND SCOPE OF EXPERIMENT

The area is divided into four main blocks, each of which has been planted with a different clone. The clones are as follows:—

A.V.R.O.S. 49	Sungei Reko 9
Prang Besar 25	Rubana 393

Each block has been divided into three main plots for comparing 3 methods of opening. The main plots have been randomised within each block. Each of the main plots has been further divided in 3 sub-plots, and the following methods of planting have been randomised within each sub-plot:—

A. Planting budded stumps.
B. Planting stumped buddings.
C. Seed-at-stake for budding in the field.

Finally each sub-plot is divided into smaller plots for manurial treatments with organic or inorganic mixtures. The smallest unit consists of a group of 12 trees, and the two manurial treatments have been randomised in a simple form within each sub-plot. Use has been made of existing drains and "Nethikans" for dividing blocks and plots. Boundary trees have been provided where necessary to exclude any border effects. The following is a diagram of the experiment:—

	B. 1 A.V.R.O.S.49				B. 2 P.B. 25	B. 3 S.R. 9	B. 4 Rubana 393
A	X	Y	C	B			
B			A	C			
C			B	A			
	α		β	γ			

α Platforms
β Trenches
γ Pitted drains

A. Budded stumps
B. Stumped buddings
C. Seed-at-stake

X. Organics
Y. Inorganics

It will be seen from the above that the 3 methods of opening have been replicated 4 times, the methods of planting 12 times, and the manurial treatments 36 times. Comparisons will be made between:—

I. Methods of opening.
II. Methods of planting.
III. Effects of organic and inorganic mixtures.

The manuring programme of the experiment was started with the following applications in the planting holes, corresponding to the two manurial treatments:—

Organic	Inorganic
Bloodmeal	Calcium Cyanamide
Groundnut cake	Safaga Phosphate
Bonemeal	Muriate of Potash
Muriate of Potash	

10.5 ounces of the inorganic and 15.5 ounces of the organic mixture were used per hole for each treatment. These quantities correspond to one ounce of each of the nutrients per plant.

PROGRESS OF WORK UP TO DATE

The following is a summary of the replanting operations, as far as possible in the order in which they were carried out, together with the costs. Special emphasis has been given in cases where a modified procedure has been adopted:—

Lining and Holing—commenced on 20th November, 1935. The whole area was lined and holed on the contour with a spacing of 15 feet between the plants and 20 feet between contours. The spacing corresponds to a theoretical stand of 145 trees per acre, but owing to rocky areas, estate roads and paths, the number of holes to the acre worked out at approximately 125. Each hole was $2\frac{1}{2}$ feet square, cut to depth of 3 feet. The cost of cutting varied from 8 to 11 cents per hole, the cost being reduced to the lower level by a change from "time" to "task" work. The cost worked out at Rs. 18.99 per acre, which includes the cost of loosening the soil at the bottom of each hole to a depth of 1 foot.

Felling—commenced on 20th December, 1935. The work was carried out on contract by elephant at the rate of 12 cents per tree. 1,207 trees of the old stand were felled in all. The contract included the preliminary cutting of laterals. Cost per acre was Rs. 14.40.

Cutting, Stacking and Burning—commenced on 24th December, 1935. The main stems, cut in twelve feet lengths, were swivelled across the contours away from any earthworks, and the smaller logs and side branches were stacked and burned. This method of timber disposal is considered suitable for areas with no previous history of root disease. Costs per acre worked out at Rs. 16.28.

Dynamiting—commenced on January, 1936. Dynamiting was undertaken to the extent necessary to ensure that each hole was of the stipulated dimensions, and was not hard bottomed. About 300 holes were treated at a cost of Rs. 10.80 per acre.

METHODS OF OPENING

The earthworks were started on 12th February, 1936. In this experiment, as mentioned before, three methods of opening were introduced in a statistical layout as follows:—

Pitted Drains—occupy an area of 3a. 0r. 17p., about a third of the whole area. A total length of 86½ chains was cut over this area. The drains were cut between the contour lines of trees and consisted of silt-pits 8 feet long, 1½ feet broad and 2 feet deep, alternately with 3 feet bunds, with a spill-level of 6 inches from the surface. The cost worked out at Rs. 33.55 per acre; this figure is high and must be attributed to the fact that in the randomisation of the methods of opening, it chanced that pitted drains were cut on an exceptionally steep area of the clearing. The work was consequently slower and included a considerable amount of stonework, and the cost per acre, being worked over a limited area, should not be used as a basis for comparison with either trenching or platforming. Working on an average gradient, approximately half-a-chain can be cut per labourer per day.

Platforms—occupy an area of 3a. 1r. 22p. These were cut on the contours with a slope of 1:5 to the bank. The cutting was started by measuring a distance of 5 feet up the slope from the centre of the hole. On a moderate gradient, the finished platform measured 4½ feet from the centre of the hole to the bank, making approximately a 3 feet cut on the bank. The platforms averaged 6 to 6½ feet in width; the extra 2 feet being added on by the overthrow of excavations. Platforms were connected to "Nethikans" to allow for overflow during heavy falls of rain. Cost per acre worked out at Rs. 45.93. Silt-pits 3 feet by 1½ feet by 1½ feet were cut on the platforms behind each hole at an extra cost of Rs. 4.25 per acre.

Trenches—were cut on the remainder of the area along the contours. Each trench was cut 10½ feet long, 2½ feet broad and 2½ feet deep, between two planting holes. Each hole 2½ feet square with a 1 foot width of uncut soil on each side formed a bund between two trenches. The sides of the bunds facing the trenches were breached towards the hole, up to a height of 1 foot from the base of the trench. These excavations which connected the planting holes with the trenches were filled with surface soil, thus giving a stimulus to the laterals to work towards the trenches, which would gradually be filled with silt and green manure. Cost per acre Rs. 34.65.

Establishing Cover-Crops—commenced on the 12th March, 1936. The following mixture was sown at the rate of 5 lbs. per acre:—

Crotalaria anagyroides	...	3 parts
Centrosema pubescens	...	1 part
Calopogonium mucunoides	...	1 part

Unfavourable weather conditions necessitated several sowings, before a desirable cover was established. *Tephrosia vogelii* was also established between planting holes about 4 feet away from the holes on the platforms, and *Gliricidias* were planted between the contour lines at the rate of 150 stumps to the acre. *Centrosema plumieri* was tried out in parts with considerable success. At the time of writing there is a heavy cover of erect and creeping plants over the whole area. Cost per acre Rs. 10.10.

Weeding—so far has been restricted to grasses, bracken and *Mikania scandens*. Woody shrubs are cut down to root level at the time of lopping cover-crops, and are not allowed to grow above 3 feet. The cost under this head worked out Rs. 6-65 up to the end of November, Rs. 7-50 would be appropriate for the year.

PLANTING

Planting was done by 3 methods, each method occupying approximately a third of the total area. The first two methods of planting commenced on the 29th May, 1936 and were carried out as follows:—

(a). *Budded Stumps*.—Plants were budded in a 1934 nursery, at Dartonfield, 1½ months before planting. Ten days before planting, the required number of budded plants in the nursery were ringed 6 inches above the bud-patch. On the day of planting these were stumped 4 inches above the bud-patch at an angle of 45°. The stumps were carefully uprooted and the cut ends dipped in wax before planting. 395 holes were supplied in all. The nursery was larger than was required for the clearing and it has been necessary to charge for the stumps at the rate of 25 cents each. Under normal estate practice, a budded stump at 15 cents would be more correct costing, if the size of the nursery is in keeping with supplies required.

(b). *Stumped Buddings*.—Plants which had been budded in a nursery two years previously, and cut back to allow the scion to grow were stumped at a height of 6 to 8 feet between two nodes in brown wood. The plants were uprooted carefully

and the cut ends waxed before they were planted out. 407 holes were supplied in all. Each stumped budding was charged at 25 cents.

The above two methods have been very successful. Only 11 supplies have been put out in the "budded stump" area. There were no casualties among the stumped buddings. Normally 3 shoots were allowed to grow on a successful stumped budding at a height of 6 feet and over. A limited number of stumps that failed to send out shoots at the required height and showed signs of dieback were cut back, and one shoot was allowed to grow. Two stumps which died back below 3 feet were cut down to 1 foot.

(c). *Seed-at-stake for Budding in the Field.*—This method of planting was done on the 8th and 9th September.

The seeds were germinated in sand-beds and only seeds which showed quick germinating capacity were used for planting. Each hole was supplied with a basket plant and 4 seeds. The cost of this method will be incomplete till the seedling plants have been budded in the field. Up to end of November the costs worked out at Rs. 13-00 per acre. About 16 cents per plant should be a fair cost for this method inclusive of budding.

The average cost of planting for the 3 methods worked out at Rs. 6-30 per acre. This is again a high figure due to experimental requirements.

Fencing—has been carried out as before, with iron posts and barbed wire, under a scheme for fencing the whole estate. Fencing with wooden *Milla* posts costs about Rs. 15 per acre.

Repairs to Earthworks.—Owing to a considerable amount of damage done to earthworks soon after these were cut, the expenditure under this head worked out to Rs. 9-97 per acre. Most of the damage was caused in an exceptionally steep area by a fall of over 12 inches of rain in one night, before the earthworks had consolidated.

A summary of the costs per acre is not given, as the different systems of opening and planting have been carried out over limited areas according to experimental requirements, and, the expenditure on certain items is higher than that which would be incurred in ordinary estate practice. The costs given should be taken in strict conjunction with the notes in the text.

THE WORK OF CEYLON RUBBER RESEARCH SCHEME

T. E. H. O'BRIEN,
DIRECTOR.

(Address given to the Ceylon Association in London June 8th, 1936).

Mr. O'Brien said:—

I am very glad to have the opportunity of addressing the members of this Association on behalf of the Ceylon Rubber Research Scheme. Although the Research Scheme is a locally controlled organisation, we recognise that a substantial proportion of our income is derived from companies which are represented in this Association, and we have often felt that many of its members are, perhaps, not as closely in touch as we should wish with the progress of our work and our views on various problems of the industry.

What I propose to do is to outline briefly the structure and policy of the Research Scheme and then to discuss various agricultural problems in which I understand that the Association is at present particularly interested, giving you our views on the position and referring to work on them which is being undertaken by the Research Scheme. I had originally intended to review our work in other directions as well, but found that there would not be time to deal adequately with all branches.

The Research Scheme as at present constituted, was established in 1930 under Ceylon Ordinance No. 10 of that year and took the place of an organisation of the same name which had been supported by voluntary contributions from estates, together with a grant from Government. The present Scheme derives its income from a cess of $\frac{1}{8}$ cent per lb. on all rubber exported from the Island, estimated income for 1936 including a small profit from our estate and minor receipts being approximately

Rs. 175,000 (say, £13,000). In this connection I would point out that the restriction of exports under the Control Ordinance has the effect of reducing the Scheme's income proportionately and that our receipts are, therefore, lower than was contemplated when the Research Ordinance was originally drafted.

The work of the Scheme is controlled by a Board of Management comprising the Director of Agriculture as Chairman, a representative of the Treasury, three representatives of the State Council, two representatives of the Planters' Association of Ceylon, two representatives of the Ceylon Estates Proprietary Association, two representatives of the Rubber-Growers' Association, four representatives of the Low-Country Products Association, and two members nominated by His Excellency the Governor to represent the interests of Small-holders; making a total of 17 members. It is estimated that Rubber cultivation in Ceylon is about equally divided between Ceylonese and European producers, and this proportion is fairly accurately reflected in the representation on the Board of the various interests concerned.

In 1933 the Board took an important step forward in the development of its policy when Dartonfield Estate, a property of 175 acres of mature Rubber in the Kalutara district, was purchased as an Experiment Station for agricultural and factory research. A further important step was taken last year, when it was decided to transfer the headquarters of the Scheme to Dartonfield from Culloden Estate, where premises are now occupied which were handed over by the former Research Scheme. Laboratories and staff accommodation are at present under construction at Dartonfield, and it is expected that the transfer will be made towards the end of this year, although the full programme of building will not be completed until 1937. There can be no doubt of the wisdom of these steps, which will enable the Scheme to be of maximum utility to the local rubber industry and the Board of Management is fortunate in being able to carry through the entire programme of capital expenditure from its available resources. The purchase price of the estate was Rs. 80,000, and the cost of buildings, including a well-equipped experimental factory which was completed in 1934, will be approximately Rs. 300,000. The Scheme's present Senior Staff comprises the Director and Chemist, Assistant Chemist, Botanist and Mycologist, Assistant Botanist, Small-Holdings Propaganda Officer, an Estate Superintendent, and a Secretary.

In referring to the policy of the Research Scheme I should like to emphasise that a small rubber-producing country is faced by just as many problems as a major producing country such as Malaya, but it is obvious that the funds available for research are proportionately smaller. It is therefore essential that a small organisation such as ours should concentrate its attention on problems which are of special local importance while keeping in close touch with work on problems of more general application carried out in other centres. Another point of importance is to ensure the continuity of research in various directions irrespective of temporary fluctuations in the prosperity of the industry. Among those connected entirely with the commercial side of the industry there is a rather natural tendency to feel when prices are low that the scientists should concentrate their attention on problems relating to the increased utilisation of rubber and then, when the position improves, to wish for attention to be transferred to problems dealing with methods of increasing production. Any attempt to make frequent alterations in the orientation of research, which is usually of a comparatively slow and long range nature, is bound to lead to disappointing results and wasted effort. These aspects of the matter have been recognised by the Research Board, and the policy which has been adopted is to maintain a balance between agricultural research and work on promoting the utilisation of rubber. It is essential for a small Institute such as ours to maintain a well-balanced staff so that sound advice can be given on any aspect of rubber production as the need arises, based either on work carried out locally or on information gathered from other centres of work.

I will now pass on to a discussion of various agricultural problems of the Ceylon Rubber Industry and the work of the Research Scheme in connection with them. Naturally attention first turns to the subject of budgrafted rubber, especially in its relation to the replanting of existing areas, and I may say straight away that we regard this as the most important problem which has to be faced in Ceylon during the next decade if the Island's position as a rubber-producing country is to be maintained. A few months ago our Botanist, Mr. Murray, gave two important lectures on the subject to District Planters' Associations under the titles of "The Case for Replanting" and "Practical Aspects of Replanting." The lectures were reproduced in our *Quarterly Circular* and a number of reprints were

also issued, so I have no doubt that they have already been read by many of those present.

Those who have read the lectures will find that I shall quote fairly extensively from them, and I make no apology for doing so, as they form the substance of our advice to the Ceylon Rubber Industry.

The backward position which Ceylon occupies at the present time in regard to the use of improved planting material is strikingly indicated by statistics of areas of budgrafted rubber in the main producing countries. The summarised figures are as follows:—

	Area of Budgrafted Rubber (in round figures)	*Percentage of total Estate Rubber*
Malaya ...	200,000 acres ...	10
Dutch East Indies	350,000 ,, ...	24
Indo-China ...	85,000 ,, ...	28
Ceylon ...	4-5,000 ,, (estimated figure) ...	1

There are no exact statistics of the area of budded rubber in Ceylon. The area for which special assessments were given in 1935 amounts to about 2,000 acres, and with immature areas the estimated figure of 4-5,000 acres is probably reasonably accurate. Whatever the exact area may be, it is evident that the area of potentially high-yielding trees in Ceylon is negligible in comparison with other countries. The figure for the total area of budded rubber in all countries is 640,000 acres, but this does not include replantings since the introduction of the Regulation Scheme, which it is understood have been fairly heavy in Java and Sumatra. Nor does it include the area planted with clonal seed, whose yield is likely to approximate to that of first-class clones. It is probably true to say that the areas now planted with improved material comprise about 7 to 8 per cent. of the total acreage under *Hevea Braziliensis*.

This may appear a comparatively small proportion, but when regarded from the standpoint of potential yield it becomes more formidable. Taking the average yield at the comparatively modest level of 1,000 lbs. per acre, the potential output from areas planted with budgrafts and clonal seed amounts to 300,000 tons per annum, or nearly one-third of present annual

world requirements. The area is thus already sufficiently large to have a very important effect on the economics of the industry when it returns to a fully competitive basis.

On broad general grounds the desirability of substantially increasing productive capacity when available rubber supplies are already far in excess of world requirements may be debatable, but from the point of view of the individual producer or the individual producing country it is clearly essential to be in a position to compete with others on a level basis. So far as can be judged from the statistical position of the industry, we must look forward to a future of comparatively low prices in which satisfactory dividends will only be earned by fully efficient producers; the criterion of efficiency being high yield and correspondingly low production costs. Ceylon producers will be at a serious disadvantage in this respect in coming years if energetic steps are not taken to increase the yielding capacity of their estates by replanting with improved material.

Two questions legitimately arise from the foregoing discussion: first, "Is there conclusive evidence that budgrafted rubber really will give largely increased yields ?" and secondly, "Is the replanting of old rubber areas a practicable proposition?"

There is insufficient time this morning to enter on a detailed discussion of the available yield data of budded rubber but there is one point with which I should like to deal. It is frequently argued that most of the yield records refer to the performance of a comparatively small number of trees and that similar yields will not necessarily be obtained when a clone is planted on a large scale. (Perhaps I had better mention that a clone may be defined as consisting of plants which are all derived by budding from one mother tree.) Those who adopt this attitude overlook the fact that there is a high degree of uniformity in the yield of the individual members of any one clone, this uniformity being, of course, due to the genetic identity of the individual trees. The influence of the root stock appears to be confined solely to the question of vigour, and the only important factor of variability within a clone is the size of the trees, as determined mainly by soil conditions. Having ascertained, therefore, that the characteristic of high yield is possessed by every member of a small group of trees derived from the same mother tree, we can be quite sure that the same property will be exhibited by every tree propagated from the same source. That, briefly, is the

principle on which the yield of commercial plantings of budgrafts may roughly be predicted from the performance of a small number of trees. Admittedly, in some cases, the trees from which tapping records have been obtained have been grown and tapped under rather favourable conditions, and it is therefore usual to discount the yield figures by 30 per cent when estimating the probable yielding capacity of the clone under commercial conditions. As an illustration of the uniformity of yield from budded plants, the following test, carried out with a well-known clone in Malaya, may be quoted. Records were kept from two groups, one consisting of 10 trees and the other of 100 trees, the groups being in each case selected at random from a larger stand. The difference between the average yield per tree in the two groups was only about 5 per cent.

It would naturally be preferable to have information regarding yields from large areas planted with first-class material, but the time factor comes in and there is inevitably a lag of 10-12 years from the time a clone is discovered to be high yielding until yield figures from mature commercial plantings can become available. Going back twelve years from the present date, we come to 1924. At this stage only a few thousand acres had been planted with budded rubber, consisting of unproved clones usually interplanted with seedlings. It was not until about 1928 that any extensive areas were planted exclusively with clones which we now regard as first-class, so most of the clearings from which very high yields may be expected are only now coming into tapping.

Available figures for the yields of commercial plantings of budded rubber were discussed by Dr. Mann, of the Rubber Research Institute of Malaya, in an article published in the Journal of that Institute in 1934 and reproduced in our *3rd and 4th Quarterly Circular* for that year. The following is the conclusion reached by Dr. Mann:—

"To sum up, the figures so far available for commercial tapping confirm the results of the early experimental tests on small numbers of trees. Although it appears hardly likely that we shall reach the maximum yield in practice indicated by the results of test-tapping, it seems probable that yields rising from 450 lbs. per acre at the sixth year of age to at least 1,500 lbs. per acre at maturity will be obtained from the modern budded plantation."

We consider that it is no longer reasonable to doubt that budgrafted rubber will give yields far in excess of those obtainable from ordinary seedling plantations, provided that clones with a high-yielding capacity and satisfactory secondary characteristics are used and provided that the budgrafts are given the necessary cultural assistance to ensure normal vigour of growth. The time must come when a yield of 400-500 lbs. per acre per annum ceases to be an economic level of production.

Turning to the question of the feasibility of replanting, it is quite reasonable to entertain doubts whether satisfactory growth can be expected on land which has been badly eroded and exhausted in the past until evidence can be adduced to the contrary. Some of the earlier replanting in Ceylon (and incidentally in other countries, too) has given disappointing results, but in most, if not all, instances the poor growth can be attributed to the lack of a rational programme of cultivation. It must be remembered that the fertility of tropical jungle soils as expressed in reserves of plant foods is seldom high. the luxuriant vegetation being maintained by a rapid turnover rather than by extensive storage. An old soil, therefore, does not stand at as great a disadvantage as might be supposed, and if the natural forest cycle of nutrient release and decomposition of vegetable debris can be restored there is every prospect of being able to grow a satisfactory new stand. This can be done to a large extent by the growth and utilisation of green manure plants which are easily established on cleared land except on the very poorest soils. Mr. Murray, when delivering his lectures on replanting, submitted a series of photographs depicting satisfactory growth on replanted land at different ages. I am sorry not to be able to show you such photographs, and it must suffice to submit our view that replanting can be expected to give satisfactory results on any area which has supported a reasonably good stand of rubber in the past. I would emphasise, however, that we consider artificial manuring to be essential in addition to the use of green manures and that replanting programmes should not be undertaken without making provision for a rational programme of manuring.

That, gentlemen, is a summary of the case for replanting. We consider that replanting with high-yielding material is a feasible proposition on the majority of estates, and it is undoubtedly the case that Ceylon is far behind other countries

in making use of the improved material which has become available as the result of scientific research. It is not suggested that budgrafts of existing clones are the last word in planting material. Continual improvement is to be expected as the result of further selection by vegetative and sexual methods, but such work is slow and it would not be reasonable to defer replanting programmes further on this account. The present restriction period, when maximum crops are not required, appears to be an excellent opportunity for such programmes to be taken in hand. Ceylon has a special advantage over other countries at present in that areas may be cleared for replanting without loss of coupons in respect of the area cleared. It is understood, however, that this arrangement is liable to alteration. I have not made any reference to the use of clonal seed for replanting as there is no material of this class available in Ceylon at present.

From the point of view of most members of this Association the vital problem of replanting will be that of finance. We frequently hear the statement, "Yes, we agree that replanting is very desirable, but we cannot afford it." Our answer to that is, "Can you afford not to do it ?" It is not within our province to suggest how replanting operations should be financed, whether by curtailment of dividends, utilisation of reserves, or by raising fresh capital, but we submit that replanting with improved material is essential if many Ceylon estates are to be in a position to compete with other producers in a few years' time. The expression used by Mr. Murray in one of his lectures was: "If many Ceylon estates are to avoid being relegated to the position of unprofitable antiques." I do not think that that will be overstating the position in ten years' time.

Replanting costs naturally vary substantially, but it is estimated that the average cost under Ceylon conditions, on the assumption that the stand will be brought into bearing in 7-8 years, is Rs.350-Rs.450 (say roughly £25-£35) per acre. Expenditure in the first year has been found to vary from Rs.125-Rs.200 (say £10-£15) per acre according to local conditions. This estimate includes the cost of adequate artificial manuring, without which provision we feel that it would be a mistake to embark on replanting operations.

I will now tell you something of what the Research Scheme has been and is doing in connection with budgrafting and

replanting. About 1924 we started collecting individual yield records of high-yielding trees on Ceylon estates, with the co-operation of the estates concerned, with a view to discovering suitable local bud-mother trees. Altogether we have collected records of about 1,000 trees. An experiment station for testing the budded offspring of selected trees was opened at Nivitigalakele in 1926, an area of 65 acres being leased from Government for the purpose. Buddings from about 130 high-yielding local trees were established on the station during the period 1927 to 1930. Last year we leased from Government a further block of 100 acres of forest land and an area of 35 acres was cleared, of which about 25 acres is being utilised for testing the buddings of a further 80-100 Ceylon mother trees.

Test-tapping of some of the earlier planted trees was started three years ago, and about 2,000 trees will be in tapping this year. It is too early to say whether any clones of outstanding merit will come to light from this work, but the early yields of several of them are quite promising. Apart from the trials on our own land, we are also co-operating with a number of estates in the test-tapping of buddings of local mother trees in their own clearings, and in at least two cases the results are becoming of commercial interest. By these steps it is hoped that proved clones of local origin will be developed to take the place of the foreign clones on which Ceylon is at present dependent.

One of the points with which I have specially been asked to deal is whether there is adequate budding material from proven high-yielding sources available in Ceylon. In answering this query I will start by saying that material of most of the first-class foreign clones, except a few which have come into prominence since the Restriction Ordinance was enacted, is represented in Ceylon nurseries. The Research Scheme established a collection of foreign clones at its experiment station a few years ago, paying special attention to some of the newer ones which had not previously been imported, and there are also budwood nurseries on a number of estates. Last year we established a five-acre nursery for multiplying budwood of the clones which are likely to be most in demand, and a small quantity of material from this nursery will become available next year. When fully established our nursery will provide material for budding some 7,500 acres per year.

In trying to explain whether supplies are adequate, I want to emphasise the importance of replanting programmes being planned well in advance. It is much cheaper to grow budwood than to buy it, and estates should aim at being independent of outside sources of supply once an initial purchase has been made of budwood or budded stumps of the clones selected for use. After deciding on the acreage to be replanted, nurseries should be laid down on the estate for multiplying the budding material to the extent required. As a rough guide it may be reckoned that budwood can be multiplied twentyfold each year.

Several cases have occurred in which Superintendents have received instructions to replant appreciable acreage at a few months' notice, without regard to whether the necessary seedling stocks and budding material were available. Replanting on this basis is bound to be expensive and likely to be unsatisfactory, as the Superintendent may be compelled to make use of inferior planting material. Seed will be ripening in Ceylon during the next two months, and I would urge any proprietor who is at all likely to undertake replanting operations within the next few years to take the preliminary step of having adequate nurseries laid down this year so that budding material and seedling stock will be available when required. My answer regarding the adequacy of budding material is that there will be no shortage if replanting programmes are planned in advance, but is not improbable if those undertaking replanting rely on purchasing the whole of their requirements from existing supplies.

Turning to work on replanting: As early as 1930 a lecture was given by the then Botanist, Mr. R. A. Taylor, in which he advocated steps being taken to replant local estates with high-yielding material. It is probably largely due to the severe depression of the last few years that so little of this work has been done in Ceylon, but it may be noted that the depression did not prevent the planting of large areas of improved material in other countries.

At our experimental estates at Dartonfield we have three experiments in progress to provide information on practical problems in connection with replanting. The areas are laid out in accordance with the latest methods of field experimentation so that the accuracy of the results can be assessed by mathematical methods.

Particulars of the Trials are as follows:—

EXPERIMENT No. 1.—AREA 7 ACRES, REPLANTED 1934.

The purposes of the experiment are firstly to compare the effects of different methods of disposal of timber on the growth of the young trees and the incidence of root disease. Secondly, to compare the effects of four different species of leguminous creeping cover plants on the growth of the new stand. The four species are *Centrosema pubescens*, *Pueraria phaseoloides*, *Vigna oligosperma*, and *Calopogonium mucunoides*. Two methods of treatment of the cover crops are also being compared. The area comprises three replicated blocks planted with different clones, namely, Glenshiels 1, AVROS 256, & Prang Besar 186.

EXPERIMENT No. 2.—AREA 13 ACRES, REPLANTED 1935.

The purpose of the experiment is to study the manurial requirements of young rubber on replanted land. The area is divided into four replicated blocks planted with different clones, namely, Tjirandji 1, Bodjong Datar 5, Hillcroft 28, and Wawulugala 359 (the latter being two promising local clones), and eight manurial treatments are being compared. The effects of utilisation of green manures in conjunction with the artificials are also being studied.

EXPERIMENT No. 3.—AREA 10 ACRES, BEING REPLANTED 1936.

The purposes of the experiment are: (1) To compare three methods of opening the land, namely, contour platforms, contour trenches and contour drains. (2) To compare three methods of establishing the new stand of trees, namely, planting seed-at-stake and budding in the field, planting dormant budded stumps, and planting budded stumps which have been allowed to grow in the nursery until they can be stumped in brown wood at a height of six feet. A comparison is also being made of the effects of organic and inorganic manures on the growth of the plants.

The experiments we are carrying out on replanting have created a great deal of interest, and we have had visits from a large number of Estate Superintendents and others to inspect the clearings. The replanting operations have been of great assistance in giving us experience of the practical difficulties and costs of replanting, and I may say in general, that our work at Dartonfield is proving of the greatest value to us in this respect and as a basis for our advisory work. As an alternative to

making advisory visits to estates, we now endeavour, when possible, to arrange for Superintendents to visit Dartonfield to discuss their problems in relation to our own operations. Mr. Murray has visited a large number of estates in conneciton with replanting and has also dealt with a large volume of advisory correspondence on the subject during the last few months. Especially in the last few months we have had a large amount of interest taken in Ceylon in the subject of replanting.

I have dealt with replanting rather extensively as it is a subject in which members of this Association and we ourselves are particularly interested at the present time, but under the restriction regulations it is only permissible to replant 20 per cent. of the total area, so that problems relating to the upkeep of the present stand of seedling rubber are of at least equal importance.

The position on many — in fact, one might say most — estates in Ceylon at the present time is that owing to the cessation of all cultivation during the years of depression and in certain localities to damage by Oidium, bark renewal is hardly keeping pace with consumption. Another factor in this connection is that there is undoubtedly a slowing down in the rate of bark renewal as the trees get older. Our observations in many districts lead to the opinion that bark conditions in general in Ceylon are less satisfactory than they were five or six years ago, and that many estates would be experiencing a gradual decline in yields except for the present restriction of output.

This position naturally raises the subject of the use of artificial manures. There appears to be little reliable evidence that manures have a direct stimulating effect on the flow of latex, but we are satisfied that they influence yield by improving bark renewal and that their use is necessary on many estates if the yield level is to be maintained. When bark conditions have already deteriorated, response to manuring is likely to be slow, and the effects may not become fully evident until a complete cycle of bark renewal has elapsed. It is for those concerned with the commercial side of the industry to consider whether it is advisable to incur the necessary annual expenditure to maintain the yield level of their seedling plantations.

An experiment has just been laid out at Dartonfield to study the manurial requirements of mature rubber and the preliminary recording of yields from the plots was started at the beginning

of the year. The effects of the three fertilising ingredients Nitrogen, Phosphoric Acid and Potassium are to be studied in various combinations, and we are also making a comparison between broadcasting the manures and digging them in with green manures. It will be some years before our own experimental results are available as a basis for advisory work, and in the meantime we express the view that Nitrogen is the main deficiency on most mature estates, especially if the trees have developed normally when young. If the growth of the trees is stunted, then there is probably a general deficiency of plant nutrients. In the case of immature trees we always advise the use of a balanced mixture.

A good deal of interest has been taken recently in Ceylon in the so-called forestry system of cultivation — that is, the provision of a cover of controlled natural undergrowth — which has been adopted extensively in Malaya in the last few years. Undoubtedly the system has had beneficial results under Malayan conditions when properly controlled, and experiments are required to determine whether similar methods can be successfully applied in Ceylon. There are, however, some grounds for supposing that difficulties may arise under Ceylon conditions which do not occur or are of less significance in Malaya and that the use of leguminous covers, whether creeping or erect, may be more suited to local conditions.

An area of 20 acres at Dartonfield was set aside at the beginning of this year for a trial of the Malayan system, and a careful record is being kept of the different species of plants which develop in the area. We consider it essential that ground cover of some sort should be provided on estates to prevent soil erosion and to build up the soil. *Vigna* has proved to be insufficiently hardy to maintain a cover under mature rubber in the absence of regular cultivation, and *Pueraria* has been largely planted in Ceylon during the past two years.

During the recent years of depression modified tapping systems were adopted on many estates, mainly with a view to reducing tapping costs. The systems consisted of tapping both sides of the trees with a half-spiral cut, either every four days without a rest or every three days, on the basis that one-half or one-third of the estate was rested in rotation. These modifications became known as the "double 3 A.B." and the "double 3 A.B.C." systems, and there were further variations in the

length of the resting and tapping periods. The systems undoubtedly served the purpose of enabling a larger amount of latex to be harvested by each tapper, thus reducing tapping costs, and there is no reason to suppose that any harm to the trees has resulted, provided that suitable modifications of the systems were selected to suit climatic and bark conditions on individual estates. A final assessment of the merits of the systems in comparison with the standard local system of a half-spiral cut on alternate days, can only be made on the basis of carefully controlled experiments. We have laid out an experiment for the purpose at Dartonfield, where a comparison is to be made between eleven tapping systems, including a number of modifications of the double cut system.

A considerable amount of information on the working of the system was obtained by the Research Scheme as the result of two questionnaires issued to estates in 1933 and 1934 We are also co-operating in two estate experiments laid out on sound modern lines, to compare the double 3 A.B.C. system (twelve months' tapping, six months' rest) with alternate day tapping. After three years the position is that bark consumption and renewal are approximately equal with both systems, but the yield of the double cut system is slightly lower. Tapping costs are, however, substantially lower with the double cut method.

From general observations we consider that the double four system is less suitable for a dry district than a wet one, and if the double three system is adopted in a dry district that the rotational resting periods should be comparatively frequent. Bark consumption with the double four system is higher than with alternate day tapping, and it has to be considered in relation to individual estates whether the rate of bark renewal is adequate to provide the extra requirements. It seems possible that double four tapping with an A.B.C.D. rotation — *i.e.*, one-quarter of the estate rested periodically — may prove to be a suitable system for adoption in the main low-country rubber-growing districts. There has been a tendency in the last year or so for estates to revert to alternate day tapping in the absence of precise knowledge of the ultimate effects of double cut tapping.

While on the subject I should like to submit the view that alternate day tapping, although suitable for young trees, may prove too severe on older plantations where the rate of bark renewal has slowed down, and it may be ncessary to adopt a

milder system such as a half-spiral cut every third day, a half-spiral cut on alternate days with an A.B.C. rotational rest, or a suitable variation of the double cut system, if depletion of bark reserves is to be avoided. Maintenance of yield depends on adequate bark renewal, and the tapping system on individual estates must be adjusted to meet this requirement.

I will now turn to a consideration of Oidium leaf disease, on which you will no doubt wish to have some information. The disease, which causes a fall of the young leaflets and stunting and distortion of the larger ones, was first reported in Ceylon in 1925 and has occurred each year since then. At higher elevations the damage caused by the disease has been very severe, but it was not until 1934 that substantial damage occurred in the main low-country districts.

In discussing the subject it is convenient to classify the rubber areas in three zones of elevation, as spore formation is much more active at lower temperatures. At higher elevations the fungus remains active throughout the year and may cause repeated defoliation as the new leaflets appear, whereas in the low-country it is only active for a few weeks when climatic conditions are suitable.

Considering first the high-grown rubber at an elevation of about 2,000 feet, there is no doubt at all that control of the disease is essential to the economic existence of the trees. In fact, in some cases where tapping has been carried on for some years without normal bark renewal taking place, we have expressed the view that the damage done is almost irreparable and that the trees could only be brought back to a condition for profitable tapping by a long programme of rest and cultivation in addition to sulphur dusting.

The next zone is what may be termed low mid-country rubber — *i.e.*, areas at an elevation of 1,000-1,500 feet, as typified by the lower estates in the Matale valley. Here the damage caused by the disease is less than at the highest elevations, but there appears to be a gradual increase in severity, and the final effects, in the absence of control measures, are likely to be similar to, though correspondingly slower than, those experienced at the highest elevations. Control of the disease is considered essential for the well-being of the estates.

The third zone comprises the main low-country districts, and, as I mentioned earlier, it was not until 1934 that the disease caused substantial damage in this zone. In that year there was a sharp attack in most localities, leading to comparatively heavy leaf-fall. There was considerable difference of opinion regarding the significance of the attack; one view being that it was due solely to abnormally wet weather conditions at the beginning of the year, and the other that there had been a definite advance on the part of the fungus. Our own view was that the latter factor had at least played some part in causing the severe attack. In 1935 weather conditions were again abnormal, hot dry weather in December and January leading to exceptionally early wintering of the trees. An attack of Oidium occurred in February, when a considerable proportion of the trees had refoliated, but late wintering trees suffered considerable defoliation. The nett amount of damage in 1935 was less than in 1934, but it was difficult to avoid the conclusion that had the winter been later or had the February rains occurred earlier, a substantial proportion of the trees would have been defoliated. In view of these features of the attacks in 1934 and 1935, it appears unlikely that Oidium will revert to its former status of comparative unimportance in low-country districts. Unfortunately, I am not in a position to discuss Oidium in Ceylon in 1936, as I have had no reports since leaving, except a remark in a letter from Mr. Murray, dated March 7th, that there had been very hot nights and consequently very little Oidium up till then.

Control of Oidium by sulphur-dusting was undertaken on a number of low-country estates in 1935 with markedly beneficial effects on the foliage. During the following south-west monsoon, however, a complication arose in that there was a sharp attack of *Phytophthora* leaf-fall, this being especially marked in the sulphur-dusted areas. The reason for this is that sulphur-dusting protects the highly susceptible flowers from Oidium infection and therefore allows the seed to set, whereas there is an almost complete absence of seed in areas affected by Oidium. In turn it is the ripening seed pods which form the chief centre of infection for *Phytophthora*. The possibility of such an attack occurring had not been overlooked, but it was more severe than had been considered likely. This may be attributed to the rather exceptional weather conditions. Settled fine weather during the flowering period led to comparatively

heavy setting of seed and the ripening of the seed occurred about a month earlier than usual, namely, in June, during a period of heavy rains, rather than in July, when we expect the rains to be nearly at an end.

We made a careful survey of the effects of *Phytophthora* on a number of sulphur-dusted estates and formed the opinion that the foliage of the dusted areas remained, in general, superior to that on adjacent undusted areas. The number of leaves on the trees was no greater and in some cases less, but they were bigger and healthier and the canopy denser. From these observations during a season favourable to *Phytophthora* but unfavourable to Oidium we reached the conclusion that there is so far no reason to rescind the recommendation to control Oidium on the more severely affected low-country estates by sulphur-dusting, although it may be desirable to modify the programme so that the degree of control is slightly less. A large proportion of estates in the Kalutara district made preparations for sulphur-dusting during 1936, and this work was just starting when I left. Our general recommendation for low-country estates was to make 5 or 6 applications of about 4 lbs. per acre.

The Research Scheme has taken a very active part in experimental work on the control of Oidium. As early as 1928 we carried out a manuring experiment in the Matale district, but heavy doses of manure in two successive years were entirely without effect in preventing leaf-fall. About the same time we made trials of liquid spraying with Sulfinette, but control of the disease was again negative. Trials of sulphur-dusting were made by us the same year with a machine imported from Java, and striking results were immediately obtained. An experimental area on an estate at an elevation of about 2,000 feet has been dusted in six successive years, yield records being kept in comparison with a neighbouring undusted area. The trials have shown conclusively that satisfactory control of Oidium can be effected by sulphur-dusting even at the highest elevation, whereas yield has decreased in the untreated field until the area is commercially untappable.

The first British dusting machine was made to our rough specification, and we have kept in touch with the manufacturers of this and other machines, pressing for modifications and

improvements when these appeared necessary. A satisfactory machine of local make is now available in Ceylon at a considerably lower price than that of imported machines.

Last year we carried out a series of large-scale dusting trials, in co-operation with estates, to compare the merits of three different types of dusting sulphur and the effects of different quantities per application. Owing to various unavoidable difficulties the results were not very clear cut, but have been of considerable value to us in connection with advisory work. Advisory work on Oidium has been very heavy and a large proportion of Mr. Murray's time in the last two or three years has been occupied in estate visits and correspondence in connection with Oidium and other agricultural problems.

The Rubber Research Board has shown considerable concern in regard to the control of Oidium on small estates and small-holdings, whose proprietors could not be expected to carry out dusting operations themselves owing to the cost of the necessary equipment. A Committee which was appointed to consider the subject reached the conclusion that it was only at elevations over 1,000 feet that the possibilities of undertaking control measures under official auspices need be considered. The total area of holdings and estates under 100 acres in extent, above this elevation, amounts to approximately 45,000 acres. It was considered impracticable to formulate any proposals for dealing with such areas at present, but on the advice of the Committee application was made to Government for a grant of Rs. 20,000 to cover the cost of sulphur-dusting 1,000 acres of small estates and holdings for the purpose of demonstrating the efficacy of the treatment and gaining experience of the type of organisation which would be required for treating a large number of comparatively scattered areas. The necessary funds were made available by Government, and the scheme has been carried out this season in the Kandy district by our Small-Holdings Propaganda Officer, Mr. W. I. Pieris. I have not had a report on the work yet, but I saw it started before I left and have since heard that it was progressing well.

That ends my summary of agricultural problems of the Ceylon Rubber Industry and the work of the Rubber Research Scheme in connection with them. When I was first asked to address the meeting I had hoped to include a discussion of problems relating to the manufacture and utilisation of rubber,

a description of our experimental factory at Dartonfield, and a survey of our proposals for work on behalf of small-holders. This could not be done in the time allotted without curtailing the agricultural side, on which information was specially invited, but I shall be glad to answer any questions dealing with the part of our work which has not been discussed. (Applause.)

The Chairman (Mr. Andrew Young): Gentlemen, there is now an opportunity for members to put to Mr. O'Brien any questions they may desire, and he will answer them. This lecture, with the questions and answers, will in due course be published as a pamphlet.

Mr. R. Stewart: There is one question I would like to ask: Should we wait till Oidium is present and then adopt sulphur-dusting to minimise it, or ought we to sulphur-dust as a precautionary measure and as a matter of estate routine at or about the beginning of each wintering season ?

Mr. O'Brien: Certainly at the higher elevation we do regard sulphur-dusting as a routine which must be conducted each year, because Oidium is bound to come. We were rather inclined in the low-country districts to suggest the same procedure, and that estates which had not yet had Oidium should dust with very small quantities of sulphur as a precautionary measure; but when we had this trouble with *Phytophthora* we had to recognise that Oidium, up to a certain point, was a very good thing in attacking the flowers and preventing seeding and thus preventing infection from *Phytophthora*. So we do not now advise in the low-country districts that sulphur-dusting should be adopted as a precautionary measure. In fact, when we do advise dusting we try not to get complete control of the Oidium but to leave enough of the infection to attack the flowers, which are more susceptible to the disease than the leaflets.

Mr. Stewart: Thank you very much, Sir.

Mr. W. Coombe: I would like to ask whether it would be best to bring back old rubber by cultivation and manuring or to budgraft and replant ?

Mr. O'Brien: Yes, that is our view, that replanting is preferable, as the response of old trees to manuring is comparatively slow. But we do not advise estates to start to replant the very worst areas. Admittedly there are areas in Ceylon hardly worth replanting. What we try to aim at is to replant

areas where the yield is low from some reason other than bad soil, either where you have had excessive thinning out or over-tapping, but not in the first place to select the worst soil.

Mr. Coombe: Would it be safe to select the seed which the Superintendent considers is from his best tree ?

Mr. O'Brien: So far as seedling stocks are concerned, where budding is done there is no point in selecting seed from high-yielding trees. All we go for in the seedling stocks is vigour. We select large and quick-germinating seeds, but vigour is the only thing which matters in the stock.

The Chairman: Mr. O'Brien says he has available a certain amount of budwood. Of course, when we replant we have got to be careful not to be extravagant and not to pay too high a price for our budwood. Would he advise an estate of, say, 700 acres of rubber to buy a limited amount of budwood from the experimental station and then grow its own multiplication nurseries for replanting operations in some two or three years' time, and, associated with that, can Mr. O'Brien tell us whether a typical low-country rubber estate in Ceylon has good enough reserve land, a few acres rich enough land, not stale land, available for the growing of these multiplication nurseries?

Mr. O'Brien: Yes, it would certainly be our advice that estates which are contemplating replanting operations should lay down their own nurseries and should simply make an initial purchase of budwood from us or some other source. If you are not going to replant for five years ahead, you might want only, say, ten yards of budwood of each clone, which you could multiply year by year. We advise that procedure because it is more satisfactory, and also, as I pointed out, if everybody relies on purchasing their requirements of budwood I think it is not improbable there will be a shortage of budwood.

In regard to estates having land available for nurseries, I think it would be rather exceptional for an estate not to have some area which could be cut out and a clearing made for nurseries where the seedlings will grow satisfactorily. We have on many estates seen rubber seedlings in nurseries growing entirely satisfactorily, with, of course, the assistance of artificial manures. I think that in the great majority of cases estates could find a suitable place to establish their own nurseries.

Mr. A. A. Prideaux: Is it necessary that first of all they should cut down their old rubber and put the seedlings into the stale land ? Is it under the Restriction Scheme permissible for a person to plant rubber in the shape of a nursery on a fresh piece of soil ?

Mr. O'Brien: I think not.

Mr. Prideaux: Then it is very unfortunate.

Mr. O'Brien: As far as I know, it is prohibited to plant any new land with rubber.

Mr. C. E. Welldon: In taking seed from the trees you would not allow the trees to be tapped: You would stop the tapping of any trees you want to take seed from ?

Mr. O'Brien: That is a point I have not really thought much about. I do not think it is a very important point.

Mr. Welldon: You think it does not matter whether the tree is being tapped or not, that the seed is equally good from a tapped tree as it is from an untapped tree ?

Mr. O'Brien: I do not think it would make any great difference.

Mr. Welldon: I think it would make a great difference. It did when I was first planting in Ceylon; I found plants from seed of mature trees that had never been tapped made better trees than plants from seed of trees that had been tapped. Then you would advise, on most low-country estates, that if there is an acreage unopened they should open the new acreage rather than replant the old ones ?

Mr. O'Brien: I am afraid that cannot be done under the Rubber Restriction Ordinance. New planting is prohibited.

Mr. Welldon: Except for that, you would advise it ?

Mr. O'Brien: Yes, from the individual's point of view, but from the country's point of view I think to a large extent that the replanting of old areas is important, apart from new planting.

Mr. G. H. Masefield: Would Mr. O'Brien mention how soon budded rubber — where replanted on land formerly under rubber — would reach maturity? In a report I have seen recently from a leading V.A. it was stated that the time might

be ten or even twelve years, and in Malaya on virgin soil it was found to take not less than a year longer to reach tappable size than it does when grown from seed.

Another point not mentioned by Mr. O'Brien was whether budded rubber was going to renew its bark in the same way as would a tree grown from seed. I have seen some extraordinarily poor renewals on budded rubber in Malaya, and I should be obliged if Mr. O'Brien could give some information on that point.

Mr. O'Brien: Our estimate of the age at which the bud-grafted rubber would come into tapping is seven or eight years. Of course, it naturally depends entirely on the growth of the rubber, which depends on soil conditions and on the treatment which you give the trees. Our point is that you must give your trees the necessary cultural assistance to enable them to come into bearing in a normal period.

As regards bark renewal. Of course, both in budded and seedling rubber you can have bad bark renewal if your trees are not properly cultivated, and also there are clones which it is recognised have a bad bark-renwal record. Such clones we should not advise being used. It is important in the selection of clones that the selection should be based not only on actual yield but on secondary characteristics, such as bark renewal. Many figures are available showing that the bark renewal of budded rubber of clones which are recommended is satisfactory, although the bark generally is thinner. I do not think there is anything to show that bark renewal in selected clones is inferior to that in seedling rubber.

Mr. Coombe: What would you say is the best stand per acre for replanted budded rubber ? I understand in Java they plant a certain number of seedlings and a certain number of budded. Would you advise planting seed ?

Mr. O'Brien: At this stage one would not advise mixing seedlings and buddings. For planting budded Rubber opinion in different countries varies. As far as Ceylon is concerned, we are doing all our plantings and advising others to do theirs at about 145 trees per acre. In Malaya I think they go up to about 200 per acre and do some thinning out afterwards. About planting seed, at present we should not advise planting anything except a definite pedigree seed, and where clearings are being

planted with such seed with the idea of not budding a much larger stand of trees is advocated. A leading agriculturist has suggested planting several thousands per acre and doing extensive thinning out on the basis of pricking tests, but at present we have no clonal seed available because none of our budded areas with monoclones or two clones together is old enough to give seed.

Mr. Clifford H. Figg: Is there any possibility of planting proved clonal seed in Ceylon ? There is not, as far as I know, any proved seed at present, nor have we, I imagine, any sufficiently isolated seed gardens where clonal seed can be proved.

Mr. O'Brien: No, we have no isolated seed stations, and we shall have to rely on information from Malaya regarding the performance of seed from different clones. We have got areas on estates planted in monoclone blocks about up to 50 acres which in due course will give seed probably of considerable value as planting material. But I think Ceylon will always be at a considerable disadvantage compared with other countries in this, because there you have very large areas where the seed in the centre of the areas is probably a fairly pure seed of that clone. And, of course, under the present regulations we cannot import any seed from outside countries.

Mr. Masefield: Would Mr. O'Brien recommend budding rubber in a wet district such as the Kelani Valley ? In similar wet districts in South India there had been very serious trouble from *Phytophthora* where budding had been attempted.

Mr. O'Brien: I certainly know a good many places in the Kelani Valley where budding has been done successfully. Of course, in each district there are practical difficulties to overcome, but I should say in general these difficulties are far more serious in very dry areas.

Mr. A. P. Waldock: Is the incidence of Oidium greater in Ceylon than in Malaya or the Netherlands East Indies ?

Mr. O'Brien: I think undoubtedly at higher elevations in Ceylon Oidium is much worse than in Malaya. I have not been to Malaya recently, but from what one gathers the worst Oidium in Malaya is about equal to the Oidium we get in our low-country districts.

The Chairman: Well, if there are no further questions—are there any more ?—it is my privilege to tender to Mr. O'Brien on your behalf our very best thanks for the informative and instructive address which he has given us to-day. (Applause.) The presentation of such an able address takes much preparation, and Mr. O'Brien has very kindly sacrificed part of his time whilst on furlough to come here to-day. I express to him your great appreciation, and I would ask you, gentlemen, to carry that with acclamation. (Applause.)

Mr. O'Brien: Thank you, gentlemen. As I said at the beginning of my lecture, I was very glad to have the opportunity of meeting this Association and giving such an address. (Applause.)

THE TAPPING OF BUDDED TREES*

INTRODUCTION

DURING the lean years of the depression interest in new planting material and in experimental work which had as its main object the improvement of planting material was necessarily small. Practically no new planting was being undertaken, the young areas planted mainly during the years 1927 to 1931 with buddings had not reached the bearing stage and the chief interest lay in the problem of economic production from mature areas.

Since the introduction of the Rubber Regulation Enactment in June, 1934, there has been a change in outlook and centre of interest. The problems of economic production have become less acute and interest is again centred on the subject of improved planting material. Under the provisions of the enactment, replanting to the extent of 20 per cent. of the acreage established prior to June, 1934, is permitted within the regulation period and those who desire to take advantage of this provision are vitally interested in the choice of the new material to take the place of the unprofitable trees which are being removed.

We have heard a good deal of discussion during the past year concerning the respective merits of buddings of the best proved clones and seedlings of known origin and their relative value as planting material for present-day use. The discussion has aroused anew all the old objections to the practice of budding although many of these objections had lost their force as evidence of the value of buddings of the best clones, particularly from the standpoint of yield, was gradually accumulated. But the striking results which have been obtained in the first tapping tests on seedlings produced by careful breeding between selected clones have had the effect of attracting renewed attention to certain undesirable qualities of budded trees.

* Lecture given at the Annual Conference of the Incorporated Society of Planters at Kuala Lumpur on October 2, 1936 by Mr. C. E. T. Mann, M.Sc. (Lond.) of the Botanical Division of the Rubber Research Institute of Malaya.

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General surveys of the information available concerning buddings and seedlings of superior origin have been given at previous meetings of this Society and its branches.

It is not intended on the present occasion to continue the discussion of the relative merits of these two principal types of superior planting material but to deal more fully with the subject of budded trees and their treatment.

A careful examination of the criticisms of budded trees reveals that many of the objections to buddings are based on a close comparison of buddings with seedlings. It is quite easily understood that a planter will form a clear conception of what he considers to be the ideal rubber tree. Since the conception is based on experience the ideal tree will have the characters of a seedling. There will be a natural tendency to distrust material which does not conform with this preconceived standard of quality and appearance. Judged by this standard budded trees must inevitably suffer, as they differ in so many important respects from seedling trees. It is necessary to judge the merits of seedlings and buddings by quite different standards, one should not look at a budding with the "seedling eye."

COMPARISON OF THE CHARACTERS OF BUDDINGS AND SEEDLINGS IN RELATION TO TAPPING PRACTICE

Although the essential differences between the vegetative characters of buddings and seedlings are probably familiar to you, it will be as well to describe them in order to show how the differences in form should be taken into consideration in determining the future treatment of the trees.

(a) A typical seedling shows a more or less pronounced taper from the level of the lateral roots to a height of about four feet. The decrease in circumference is rapid over the first foot from ground level becoming more gradual with increase in height until above a height of about fifty inches the trunk becomes practically cylindrical.

The trunk of a budded tree is almost cylindrical from the level of the union with the stock up to the level of the first lateral branches. Girth measurements taken at heights of 10 inches, 30 inches and 50 inches on buddings of a typical clone gave readings of girth of 30 inches, 28 inches and 27 inches respectively. Comparison of girth measurements on large numbers of seedlings and buddings show that the difference in

girth at heights of 20 inches and 40 inches is only 5 per cent. in buddings whilst in seedlings the mean difference is 15 per cent. The girth of a seedling tree at ground level may be double the girth at a height of 40 inches whilst the difference in girth at corresponding levels on a budding is seldom more than 10 per cent.

(b) In a normal seedling tree, accompanying the gradual decrease in girth there is a corresponding decrease in bark thickness from the base of the tree upwards. This change in the thickness of the bark is accompanied by a change in structure both in the outer layers and the inner layers of the bark. The structure of the outer layer of bark will be dealt with in more detail later; the innermost layers of bark, which contain the latex vessels, are of particular interest here. Examination of the productive layer of soft "bark" shows that in a normal seedling tree the number of latex vessels at the base of the tree is approximately fifty per cent. greater than the number found at a height of 40 inches.

In a typical budded tree the difference in bark thickness measured immediately above the union and at a height of 40 inches is small and seldom exceeds 15 per cent. Corresponding with this uniformity in thickness is a uniformity in structure both of the outer corky layer and of the inner, soft layer containing the latex vessels.

To illustrate this important difference in the quality of the bark of buddings and seedling trees the results of a detailed examination of bark sections taken at heights of 5, 20 and 40 inches from ground level on buddings and seedlings may be given. The examination was made on 208 buddings of six different clones and 485 seedlings of mixed origin. The buddings were just over 5 years of age and the seedlings 7 years of age. The actual number of latex vessel rows in the buddings was considerably higher than that in the seedlings at all levels but for the present this is not the point to which I wish to draw attention. The relative proportion of latex vessels at different levels is the chief point of interest; in buddings if the full count of latex vessels at the base of the trunk is taken as 100, then at 20 inches the number is reduced by only 5 per cent. and at 40 inches by only 10 per cent. For seedlings, the corresponding figures are 100 per cent. at the base of the tree, which is reduced by 27 per cent. at 20 inches and by 40 per cent. at 40

inches. It may be suggested that to compare the bark of buddings of good clones with that of a group of ordinary unselected seedlings is hardly a fair comparison. To meet this objection, the ten highest-yielding trees of the group of seedlings examined have been considered separately and it is again found that the number of latex vessels at 20 inches is less by 25 per cent. than the number at the base of the tree. It is a point of interest that these selected seedlings include the mother trees of the buddings with which these comparisons are made.

TABLE I.

Distribution of Latex Vessels in the Bark of Buddings and Seedling Trees at Different Heights.

		Number and Percentage of latex vessels at height of		
		5 ins.	20 ins.	40 ins.
1. Buddings	...	20	19	18
		100%	95%	90%
2. Seedlings	...	15	11	9
(Unselected)	...	100%	75%	60%
3. Selected Seedlings (Mother trees of the buddings in 1)	...	20	15	—
		100%	75%	—

The characters discussed so far, changes in girth and the quality of the bark with increase in height on the trunk have a very close bearing on yield and tapping practice. In seedling trees it is clear that the highest production will be obtained at the lowest levels where the maximum length of the tapping cut on bark of the best quality is obtained. Before considering the question of yield in more detail, there is a further characteristic difference between the bark of buddings and seedlings which must be described.

(c) It is the common practice to speak of the whole of the tissues outside the wood of a rubber tree as the bark. Although this may not be correct botanically the term is clearly understood in relation to tapping practice and we will retain it for the purpose of this discussion.

The "bark" is separated from the wood by the actively growing cambium layer from which new wood vessels are formed towards the inside and new bark tissues towards the outside. A longitudinal section taken through the bark shows that it is made up of an inner layer of soft tissue, an intermediate layer consisting of a mixture of soft tissue and harder elements known as stone cells and an outer layer composed of hard and for the most part dead cells consisting mainly of cork. (Strictly speaking only this hard outer layer is the true bark, the inner living layers constitute the bast). The relative extent of these three principal zones of tissue varies considerably in seedling trees. Different clones may also show considerable differences in bark structure although within a single clone the buddings show a high degree of uniformity in this respect.

The most important tissues, from our point of view, the latex vessels, are practically confined to the inner layer of soft bark and the innermost layers of the stone cell zone. Outside this region no latex is produced. (The relative extent of the different tissues in the bark of typical buddings and seedlings was shown diagrammatically.) The most noticeable difference in the bark structure of seedlings and buddings is the relatively small development of cork on the bark of buddings. In seedling trees the corky layer represents from one-third to one-half of the total bark thickness. In most budded trees the cork layer accounts for less than 10 per cent. of the total bark thickness. Clone B. 84 is quite exceptional among the better known clones in this respect; the cork layer on buddings of this clone may represent 25 per cent. of the total bark thickness. A further interesting feature is the relatively greater development of the stone cell layer, the zone between the cork and the soft bark, in buddings as compared with seedlings. It appears that the deficiency in the corky, protective layer is to some extent counter-balanced by a heavier development of protective tissue below the cork layer. The actual thickness of the latex bearing zone is approximately the same in the buddings and the selected seedlings examined. The sections used to illustrate these differences in the structure of the bark of buddings and seedlings have been prepared from samples of bark taken at a uniform height of 20 inches on trees about $6\frac{1}{2}$ years of age. These essential differences in bark structure between buddings and seedlings have been the source of the most numerous criticisms and doubts concerning the value of buddings.

In seedling trees the heavy development of cork is most pronounced at the base of the tree within the normal tapping levels. Usually the development of a thick cork layer is absent from the upper portions of the trunk and the main branches so that the bark becomes smooth and similar in appearance and texture to that of a normal budding. That a heavy cork layer is normally present on bark which it has been the custom to tap appears to have been responsible for a firmly fixed belief that there must be something fundamentally unsound in the practice of tapping bark which is not provided with a heavy cork layer. In any discussion of tapping of budded trees the objection to tapping "branch" bark is generally heard. It is difficult to find actual evidence that branch bark could not be tapped satisfactorily if it were found profitable to do so. Without this evidence the objection to tapping "branch" bark and its application to budded trees carries little weight. The main point it is desired to make, is that differences are not necessarily defects and satisfactory answers to criticisms can only be obtained from the results of practical tests.

There is one important respect in which the differences in structure of the bark have an important practical bearing. Although the corky layer of the bark of a seedling tree contributes nothing to the yield of latex, during the actual tapping operation it provides a firm channel along which the tapper's knife can work smoothly. The tapping knife is steadied by the extra resistance of the tough corky layer and the risks of too deep tapping and wounding are minimised. Tappers who have been accustomed to work on ordinary seedlings will at first experience some difficulty in tapping buddings. They will either be inclined to wound frequently or, if they have been suitably impressed beforehand concerning the dangers of wounding, tapping is likely to be too shallow. This is a practical difficulty which can be overcome by a little careful attention in the early stages.

The absence of the thick cork layer on buddings reduces the width of the channel available for the flow of latex at tapping. If the tapping cut is given the same slope as that normally used on seedlings there is a tendency for latex to overflow down the bark. Tapping with a steeper slope of about 30 degrees overcomes this difficulty.

It is now proposed to describe briefly certain experiments which illustrate the bearing of the special characters of budded trees on the choice of a tapping system.

YIELDS OF BUDDINGS AND SEEDLINGS AT DIFFERENT TAPPING HEIGHTS

It is well known that yield of a seedling tree decreases with increase in the tapping height. (The relationship between the height of cut and yield was shown by means of a graph.) Yield at a mean height of 25 inches is taken as 100 and it is found that at ground level the yield is increased by 50 per cent; at a height of 50 inches the yield is reduced by 25 per cent. On the same graph a second curve was drawn from records obtained from budded trees of a single clone. It is unfortunate that the data is so limited, but it is sufficient to illustrate that the change in yield with increase in the height of the tapping cut is much less marked in buddings than in seedlings. The lower portion of the curve has not been complete as the yields of buddings of different clones vary considerably as the tapping cut approaches the union.

More complete records are available for yields of budded trees tapped at heights of 20 inches and 40 inches. For buddings of 11 clones the average yield during the first tapping year on trees opened at a height of 40 inches is found to be almost exactly 10 per cent. less than the yields of trees opened at a height of 20 inches. For seedling trees the difference in yield between trees tapped at corresponding heights is more than double this figure. Certain clones appear to give practically the same yield at tapping heights of 20 inches and 40 inches.

The essential differences in the structure of the tapping zone in buddings and seedlings is thus shown to have an important bearing on yield. It is clear that in the choice of a tapping system which will prove satisfactory for budded trees full consideration must be given to their special characteristics. It is unlikely that the systems which have been proved by long experience to be satisfactory on seedling trees will be the best systems for buddings.

THE EFFECT OF THE UNION ON THE YIELDS OF BUDDINGS

The graph illustrating the relationship between yield and tapping height in seedling trees shows a steady increase in yield as the tapping cut approaches the base of the tree. Over the

lowest section of bark the increase in yield is most pronounced. In budded trees we find that the reverse is true. In general it is found that as the tapping cut approaches the union yields do not increase, but may actually decrease. The behaviour of different clones is not constant, certain clones may show this "union effect" when the tapping height is several inches from the union, in others it is not apparent until the tapping cut reaches a much lower level.

To illustrate this point I have taken the results of an experiment carried out on two clones. In each clone the yields of two groups of trees tapped at heights of 6 inches to 2 inches above the union are compared with trees tapped from 40 inches to 36 inches above the union. The figures are given in Table II.

Two systems of tapping were used, alternate daily tapping and daily tapping in alternate months.

The results of these experiments demonstrate clearly the *relative* decline in yield which takes place as the tapping cut approaches the union. The word relative is important, it should not be assumed that there was a pronounced fall in yield on the lower tapping cut, actually there was a slight increase in yield, the main point is that the yields on the upper cuts increased more rapidly than the yields on the lower cuts. The difference between clones is also illustrated by the examples selected. In Clone B. 58 although the yield of the upper cut increases more rapidly than that of a lower, the latter still remains the highest yielding cut to within two inches of the union. In Clone B. 84 the rate of increase in the yield of the upper cut is relatively more rapid and its yield exceeds that of the lower cut when the latter is about 4 inches from the union on trees tapped on the alternate day system.

TABLE II.

The Effect of the Union on Yield of Buddings

			Yield of Low Cut as Percentage of Yield of High Cut. Height of tapping cuts in inches.							
Clone	Tapping System		40 6	39¼ 5¼	38½ 4½	37¾ 4	37 3½	36¼ 3	35½ 2½	34¾ 2
B. 58	a.d.	...	150	144	149	138	123	115	100	103
	d.a.m.	...	121	—	136	—	—	101	—	90
B. 84	a.d.	...	125	104	115	98	104	90	83	87
	d.a.m.	...	93	—	84	—	—	76	—	75

Note.—a.d. Tapping alternate daily on half-circumference—no rest.
d.a.m. Tapping daily on half-circumference—in alternate months

If will be noticed that with the daily alternate monthly system of tapping the effect of the union on yield appears to be considerably more marked. This is evident in Clone B. 58 and quite pronounced in Clone B. 84.

From the results of experiments carried out elsewhere it has been recommended that budded trees should be left untapped from 6 to 8 inches from the union. The results on which this advice is based were obtained with the daily alternate monthly system of tapping. It is interesting to note that our results obtained with Clone B. 84 in the present experiments would support this recommendation. At the same time, as the most usual system of tapping in this country is the alternate day system in view of the results we have obtained it appears to be unnecessary to discontinue the tapping of buddings until a considerably lower level is reached when the alternate day system of tapping is used.

BARK RENEWAL ON BUDDED TREES

Of all the doubts which have been expressed concerning the value of buddings probably the most numerous have been on the subject of bark renewal. One of the alleged defects of "branch bark" is that it will not renew. It is unfortunate that some of the earliest clones to be tested were used for commercial planting before information was available concerning their secondary characters, particularly bark renewal. Although as soon as weakness in this respect was observed the defective clones were removed from the list of those recommended for planting, the warning came too late to prevent the planting of considerable areas with unsatisfactory clones. It seems likely that many of the rumours concerning the defects of budded trees have their origin in these unfortunate areas. Such characters as thinness of the primary bark and a slow rate of bark renewal are clonal characters. Before a clone can be recommended for commercial planting it is now necessary to obtain conclusive evidence that secondary characters of this nature are satisfactory. It is not sufficient that a clone should give a very high yield in the early years of test, other characters are of almost equal importance.

In an area containing buddings of a number of clones which have been tapped continuously since 1928, we have made regular observations on the rate of bark renewal. The records for two clones are given in Table III and they show that the rate of bark renewal may be entirely satisfactory.

TABLE III.

Bark-Renewal in Buddings.

Clone	Thickness of bark in millimetres								
	Virgin Bark		Renewed bark:—age in years						
	4 in.	50 in.	7	6	5	4	3	2	1
B. 84	11.8	11.3	10.4	10.3	10.2	10.1	8.8	8.4	7.5
D. 65	11.7	10.4	9.8	9.4	9.3	8.8	7.1	6.4	5.7

In addition to the measurements examinations of the structure of bark have been made. It has been found that after 4 years the structure of the inner layer of renewed bark is practically identical with that of the virgin bark. The difference in total thickness is accounted for mainly by the smaller development of the stone cell layer in the renewed bark.

During 1935 renewed bark representing 7 years' renewal was tapped and it was possible to make careful comparisons between the yields of trees tapped on renewed bark and virgin bark at the same tapping height. Six clones were included in the tests. It was found that as the tapping cut approached the renewed bark, yields decreased slightly below the level obtained on trees having virgin bark below the tapping cut. As the tapping cut entered the renewed bark there was an increase in yield, more marked in some clones than others, but in all clones the yield on renewed bark was relatively higher than on virgin bark at the same height.

It is not possible to give in full the detailed results here, but the figures summarised in Table IV show that despite the fact that many of the trees were tapped on renewed bark, during 1935 all except D. 65 showed an increase in yield.

TABLE IV.

Yields of Buddings Tapped on Renewed Bark.

Year	Nature of Bark	Tapping height in January	Yield in pounds per tree per annum					
			A.44	B.58	B.84	D.61	B.16	D.65
1933 ...	Virgin	40 in.	9.3	9.6	15.9	7.1	15.1	20.0
1934 ...	,,	30 ,,	9.5	12.9	18.5	10.9	18.6	26.0
1935 ...	Renewed	20 ,,	10.0	14.6	19.2	11.8	19.1	23.2

Tapping system: alternate day tapping on half circumference.

RATE OF INCREASE IN YIELD

Although it is generally accepted that buddings of the best clones now recommended for planting are capable of very high yields when young, there appears to be a general impression that they will not be able to maintain their yield or show a steady increase in yield with age in the same manner as seedlings. This is still another of the questions which will only be answered with certainty by future results, but from our present evidence there seems to be little cause for anxiety.

Graphs illustrating the yield records of the Pilmoor Clones, B. 84 and D. 65 were shown. Although the trees have been tapped continuously from the time they reached a girth of 16 inches there is little evidence so far that their good performance at an early age has not been maintained.

It is of interest also that young buddings made in 1928 from the original buddings of Clone B. 84 have now been tapped for three years and have given the following yields:—

6th year	...	7.2	pounds	per	tree
7th ,,	...	9.4	,,	,,	,,
8th ,,	...	11.2	,,	,,	,,

So far they are repeating closely the performance of the original buddings.

YIELDS FROM BUDDED AREAS

It is discouraging to us and not very helpful to you when confirmatory evidence of the value of buddings is required, that actual records of the yields of large budded areas in commercial tapping are difficult to obtain. The chief reasons for this lack of information are:—

(a) The extensive planting of buddings of clones which can be regarded as "proved" dates from about 1928, so that the trees would not have been ready for commercial tapping much before 1934.

(b) The introduction of Rubber Regulation has made it unnecessary to tap young areas. It is generally possible for an estate to obtain the full exportable quota from mature areas at a lower tapping cost than it would be possible to maintain even from a high-yielding area of young buddings. Under present conditions cost per pound is more important than yield per acre.

Although the area is small, a fair index of the yield per acre obtainable from buddings of the best clones can be prepared from our records of an experimental area.

The records are summarised in Table V below.

The area was planted in 1924 and the actual area allocated to each clone is accurately known. This figure is used to compute the yield per acre for each clone. No allowance is made for losses. Since 1931 the method of tapping, collecting and manufacture of the rubber has been made to conform as closely as possible with ordinary estate practice. The crop from each clone is manufactured as smoked sheet and lower grades are made up as crepe in the usual way. The total weight of dry rubber obtained from each clone is recorded monthly.

The figures presented in Table V give an accurate record of the actual yields per acre obtained from the different clones. The stand of trees per acre is low, considerably lower than it would be in a present-day planting, and it is reasonable to expect that even better results could have been obtained with a higher initial density of planting.

TABLE V.

Yield Per Acre.

		Yield per acre in Pounds. *No. of trees per Acre.*				
	Acreage					
Tapping year		1931	1932	1933	1934	1935
Age in year :		6 to 7	7 to 8	8 to 9	9 to 10	10 to 11
Clone A. 44 ...	1.34	590	613	530	503	491
		73	*64*	*58*	*53*	*53*
Clone B. 58 ...	.84	743	864	845	983	1,049
		79	*78*	*78*	*77*	*77*
Clone B. 84 ...	.50	735	959	1,068	1,273	1,258
		66	*68*	*70*	*70*	*68*
Clone D. 61 ...	.46	467	549	479	634	695
		52	*52*	*57*	*56*	*56*
Clone D. 65 ...	.06	1,232	1,423	1,409	1,668	1,530
		72	*72*	*72*	*72*	*72*
Clone B. 16 ...	1.08	792	906	998	1,128	1,188
		64	*63*	*64*	*63*	*62*
All Clones ...	4.28	760	886	888	1,032	1,035
(Mean)		*68*	*66*	*67*	*65*	*65*

Further records of yield are available from comparatively large blocks of buddings of a number of clones in monoclone plantings. The blocks are from 60 to 70 acres in size and each block contains 18 tapping tasks. Tapping is alternate daily with a single cut from left to right commencing at a height of 40 inches from the union. During the first tapping year the following yields have been obtained:—

	Age of buddings at Commencement of Tapping. Years.	Yield in pounds per acre.
Clone P. B. 25 ...	5	578
Clone S. R. 9 ...	6	324
Clone AVROS. 49 ...	5½	517
Clone AVROS. 50 ...	5½	464
Clone AVROS. 152 ...	5½	393

At the conclusion of the first tapping year the blocks of 18 tasks have been divided into 3 sub-groups each containing 6 tasks. The first group is tapped alternate daily, the second on the A.B.C. system with periods of six months' tapping and three months' rest, the third group is tapped every third day.

The results obtained with P.B. 25 follow, for the other clones the work is not yet sufficiently advanced for discussion.

Clone P.B. 25.—Buddings 6 years of age at the commencement of the experiment

Tapping System	A.D.	A.B.C.	3rd daily
**2nd Year.*			
Yield in lbs. per acre ...	757	539	543
Yield as % of A.D ...	100%	71%	72%
Mean yield per cooly in lbs. dry rubber ...	13.2	14.0	14.0
3rd Year.			
Yield in lbs. per acre ...	898	694	695
Yield as % of A.D ...	100%	77%	77%
Mean yield per cooly in lbs. dry rubber ...	15.4	17.8	17.8

* During the first year all tasks were tapped on the alternate daily system. When the comparison of the three systems of tapping was commenced the tapping height on all trees was 30 inches from the union.

The yields from the tasks tapped alternate daily are excellent and they are well in excess of the maximum allowance for budded rubber of this age permitted by the rules for the assessment of young areas.

TABLE VI.

Summary of Yield Records of Young Budded Trees from Tests carried out on Estates.

Clone		Yield in pounds per tree				
		1st tapping year		2nd tapping year		
		No. of trees	Yield		No. of trees	Yield
Tjirandji 1	... (3)	38	7.9	(1)	10	11.8
A.V.R.O.S. 49	... (3)	5,440	4.6	(1)	20	5.8
A.V.R.O.S. 50	... (3)	5,513	4.8			
A.V.R.O.S. 152	... (2)	5,418	3.6			
B.D. 5	... (3)	28	4.4	(1)	20	7.6
B.D. 10	... (2)	27	5.0	(1)	20	6.1
P.B. 25	... (1)	5,400	5.7	(1)	5,400	7.2
P.B. 23	... (1)	13	4.7			
P.B 186	... (1)	21	4.7			
S.R. 9	... (1)	5,400	5.0			
A. 44	... (3)	56	8.6	(2)	39	9.6
B. 84	... (3)	60	6.8	(2)	40	9.9
B. 16	... (2)	40	9.2	(2)	40	11.6
D. 61	... (2)	40	6.1	(2)	40	8.9
B. 58	... (2)	40	6.7			

Numbers in brackets indicate number of sources from which records have been obtained.

The yields obtained under the A.B.C. and 3rd day systems of tapping are also very satisfactory. Production in pounds per acre is practically the same on both systems. The proportional loss in yield is less than the proportional reduction in number of tapping days. It is clear, therefore, that the trees are deriving some benefit from the extra rest allowed by the lighter tapping systems. A point of particular interest at the present time is the very satisfactory yield per tapper obtained on the lighter systems of tapping. A yield of 18 pounds per cooly on a task of 300 trees which are not yet 8 years of age reckoned from the date of budding, is exceptionally high.

From a number of estates on which buddings have now reached the tapping stage we are receiving regular records of yield. On the whole the yields are coming up to expectations. We should like to have many more records of this sort from estates where buddings of the best known clones are now being tapped. In Table 6 a summary of the records from tests which have beeen continued for a full year or more is given.

SUMMARY

In the course of this lecture the chief aim has been to illustrate the manner in which budded trees differ from seedling trees in many important respects. It is important that these differences should be fully appreciated as it has been shown that they have an important bearing on tapping procedure.

It is realised that it will probably prove difficult to give buddings the different treatment their differences in character require in the older areas where buddings and seedlings have been planted together. In view of the differences in bark thickness and structure tapping will be difficult. There will be a tendency either to tap too deeply on the buddings or if the buddings are correctly tapped then it is likely that the seedlings will not be tapped deep enough. If possible it might be arranged that different tappers are allocated to buddings and seedlings or it might be feasible to arrange that the buddings and seedlngs are tapped on alternate days. In large blocks containing only budded trees, particularly if the monoclone system of planting has been followed, the practical difficulties of tapping will be minimised. The general uniformity of the trees should actually make the tapping of buddings very much easier than the tapping of seedlings where the variation in bark conditions from tree to tree may be very great.

SYSTEM RECOMMENDED

From the experience and information we have gained from tapping experiments on a large number of different clones it is recommended that tapping of buddings should be commenced on the following systems:—

(*i*) The minimum girth should be not less than 20 inches at a height of 40 inches from the union of bud and stock.

(*ii*) Trees should be opened on a half-circumference, the lowest point of the tapping cut being 40 inches from the union.

(*iii*) We prefer the single, spiral cut sloping downwards from left to right, but where there is a particular preference for the "V" cut it may be used. The advantage of the half-spiral cut is that it is quicker to tap than the "V" and probably gives a slightly higher yield. On the other hand, the "V" cut reduces the danger of loss of latex by overflowing from the cut.

(*iv*) The angle of slope of the cut should be about 30 degrees.

(*v*) Tapping alternate daily with bark consumption of $\frac{3}{4}$ to $\frac{7}{8}$ inch per month, is recommended for the first two years. It has been shown that by tapping on the ABC system or tapping every third day, very satisfactory yields per acre can be obtained from young buddings and the yield per tapper can be appreciably increased. Under present conditions the use of these lighter systems can be recommended, probably the third day system will be preferable to the ABC system with alternate day tapping, for the majority of clones.

There are one or two minor points of practical importance; it should not be forgotten that the heavy cork layer on the bark of a seedling tree provides a useful anchorage for the spout and cup hanger. The spout can be tapped into the corky bark to a fairly deep level without causing damage, similarly the usual type of cup hanger which is held in position by two short claws pressed into the bark is generally satisfactory on seedlings. Greater care is required on buddings, spouts of lighter construction are required and the expanding type of cup-hanger support which does not penetrate the bark should be used.

REVIEWS*

Diseases and Pests of the Rubber Tree—By Arnold Sharples. *Macmillan & Co.*, London, 1936, Price 25/-.

UNTIL the publication of this volume the most important work in the English language on the diseases of Rubber was "The Diseases and Pests of the Rubber Tree" by T. Petch. The last edition of Petch's book was issued as long ago as 1921, and in view of the great advances which have been made during the last decade, in particular as the result of researches carried out by the Rubber Research Institute of Malaya since 1931, a new authoritative volume is very welcome. Prior to his retirement, Mr. Sharples worked on Rubber disease problems in Malaya for more than twenty years, and there is no one more competent to supply what was fast becoming a long-felt want.

The book is divided into three parts. Part I contains general remarks on plant diseases, a brief account of the structure and *modus operandi* of fungi, and a discussion on the influence of external factors on Rubber diseases. Part II comprises an elementary description of the form and functions of green plants, and Part III is an exhaustive account of all the specific diseases and pests which attack *Hevea*.

In his preface the author expresses the hope that Parts I and II will receive due attention from planters though the subject matter may present some intricacies to laymen, and states that the planter who makes a study of these elementary treatises will be in a position to appreciate the remaining portions in a practical manner. The reviewer would go further and state that an elementary grasp of the functions of both parasite and host is absolutely essential to a sound working knowledge of plant diseases, and that a planter cannot be considered to be fully efficient without such knowledge. A pathological condition is merely an abnormal physiological condition, and the normal state must be understood before the significance of

* Reprinted from *The Tropical Agriculturist.* Vol. LXXXVII, No. 2.

abnormality can be properly appreciated. These important sections of the book are quite short and very readable, and may be commended to all whose profession is directly concerned with the growing plant.

In the very thorough descriptions of the individual diseases the author is writing mainly for the benefit of the Malayan planter. Quotations relating to work in other countries are, however, given in full and, indeed, throughout the text emphasis is laid on the relation between the incidence and severity of diseases and external factors due to climate and soil, and the differences encountered in the various producing countries are fully represented. Each chapter concludes with a list of references which enable the investigator to pursue the subject in greater detail.

Included in Part III are chapters on all the major and minor fungus diseases, on damage due to lightning and sun-scorch, on animal and other pests and on the treatment of diseases with special reference to tar derivative fungicides.

The book concludes with a chapter on the so-called "forestry" methods of cultivation, with special reference to the influence of such methods on diseases. Although it is difficult to avoid the impression that the author's judgment has been somewhat biassed by outside criticism of the scientific staff in Malaya, he nevertheless effectively explodes the absurd claims made by the extreme protagonists of forestry cultivation that such methods constitute an almost universal panacea. That the *controlled* growth of natural covers is of value in soil management cannot be doubted and is, indeed, no new idea, but it is extremely improbable that the full list of advantages claimed by the most ardent advocates of forestry methods will ever reach full fruition.

For the Mycologist there is an appendix giving a list of fungi recorded on *Hevea* in Malaya, while for the lay reader a useful glossary of technical terms is included.

The text comprises 480 pages, four coloured plates and a large number of excellently reproduced photographs. Apart from one or two printing errors the only mistake found by the reviewer occurs on page 350; a difference in temperature of 20°C is equivalent to 36°F, not 68°F as stated.

The author affirms that there is no special aim to be attached to the book beyond recording the progress of pathological research in Malaya. One feels that he is unduly modest since the book goes far beyond the mere recording of experimental results. To the fellow investigator the individual views of an experienced pathologist are always stimulating and Mr. Sharples has been generous in this respect. To the planter who wishes to know something of the crop under his control both in its normal and diseased condition, this volume will prove a valuable and interesting text-book.—R.K.S.M.

Rubber Latex—By Henry P. Stevens and W. H. Stevens. *The Rubber Growers' Association Inc.* London, 1936, pp. 224.

HISTORICALLY, the use of latex as a raw material is not new in so far as it was employed at least 200 years ago by the inhabitants of the Amazon Valley in the production of rubber articles. In 1824 Hancock obtained patents for the preparation of fibrous rubber products and paints but his processes were never fully worked out because of the difficulty of transporting latex from the producing countries. The rapid development of recent years in the direct application of latex dates from the discovery of improved methods of preservation and shipment. To-day the applications of latex are so many and varied that the rubber producer cannot afford to be ignorant of the subject. In the last ten or twelve years the technical literature has grown to an alarming extent and in particular the patent literature is now so complicated that it is a matter of some difficulty to gauge from it the state of contemporary knowledge and industrial practice.

Many workers in this field have reason to be grateful to Messrs. H. P. and W. H. Stevens and to the Rubber Growers' Association for a publication which summarises the position in its more important theoretical and practical aspects. This booklet is the fourth edition of one that first appeared in 1928.

It is divided into two sections. The first half is devoted to the properties and behaviour of latex and to its production and industrial utilisation. Among the new subjects touched upon in the present edition are the measurement of stability, removal of water soluble constituents, the production of water paints, flooring and road surfacing materials. A paragraph is included on the botanical significance of latex and a brief description is given of some of the better known latices derived from laticiferous plants other than *Hevea*.

The second half contains a list of British Patents from 1920 onwards with application dates and short abstracts.

The booklet is intended mainly for the non-technical reader who wishes to learn something about the trend of developments in this comparatively new branch of the rubber industry. At the same time it is a book that provides rubber technologists with an excellent and much-needed résumé of the existing state of our knowledge of latex.—M.W.P.

MEETINGS ETC.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirty-fourth meeting of the Board of Management held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 10 a.m. on Thursday, 17th September, 1936.

Present.—Mr. E. Rodrigo, C.C.S. (in the chair), Mr. C. H. Collins, C.C.S. (Deputy Financial Secretary), Messrs. I. L. Cameron, L. M. M. Dias, George E. de Silva, M.S.C., L. B. de Mel, J.P., U.P.M., F. H. Griffith, M.S.C., Col. T. G. Jayewardene, V.D., Messrs. J. C. Kelly, F. A. Obeyesekere, J. L. D. Peiris, C. A. Pereira, B. M. Selwyn, E. W. Whitelaw and Col. T. Y. Wright.

Mr. R. K. S. Murray, Acting Director, was also present by invitation.

Apology for absence was received from Mr. E. C. Villiers, M.S.C.

1. MINUTES

(a) Draft Minutes of the thirty-third meeting which had been circulated to members were confirmed and signed by the Chairman.

(B) MATTERS ARISING FROM MINUTES

1. *Application for Grant from the Department of Industries.*—It was reported that a deputation consisting of two members of the Board and the Acting Director had, as decided at the last meeting, interviewed the Minister for Labour, Industry and Commerce. No reply had yet been received from the Minister, but it was understood that he was prepared to recommend the application on certain conditions. The action to be taken on receipt of a reply from the Minister was left to the Chairman.

2. *Sale of Budwood and Budded Stumps.*—A list of applications received in response to the advertisement inserted in the local daily papers was circulated to members. It was decided that the orders for budwood could be met in full and that budded stumps should be allocated on a sliding scale as suggested by the Acting Director, with the proviso that in no case should the quantity allotted be more than sufficient for replanting 10 per cent of the total planted area calculated on the basis of 125 trees to an acre.

Prices to be charged were fixed at 25 cents per budded stump and 50 cents per yard of budwood.

3. *Mr. T. E. H. O'Brien's and Mr. R. K. S. Murray's Agreements.*—A Sub-Committee consisting of three members of the Board was appointed to consider the terms of service of all officers recruited from abroad and to make recommendations to the Board with a view to the adoption of a uniform scheme.

4. *Bulletin on Oidium Leaf Disease.*—Agreed that the draft which had been circulated to members should be published, and that copies of the Bulletin should be sent to the Minister for Agriculture and Lands and the Treasury with a covering letter explaining the Board's resolution.

2. DECISION BY CIRCULATION OF PAPERS

Reported that members had agreed to the terms of the reply to the Secretary, Central Board of Agriculture, regarding the use of scrapers, which had accordingly been sent.

3. EXPERIMENTAL COMMITTEE

The following recommendations of the Committee were approved:—

(a) Scheme and estimate for supplying water to the Junior Staff bungalows.

(b) Sale of the following buildings at Culloden to the Rosehaugh Company:—Director's bungalow; Small-Holdings Propaganda Officer's bungalow; Clerks' quarters (2). and demolition of the other buildings at Culloden, the materials to be used in the buildings to be constructed at Dartonfield.

4. PINNAGODA CLEARING

An estimate of Rs. 517 for clearing and planting 2 acres of nurseries for the purpose of providing budded stumps for sale in 1938 was approved.

5. STAFF

(a) Decided that a bungalow on Pimbura estate should be rented for the Secretary to the Director on removal of the Headquarters to Dartonfield, pending the construction of a bungalow in 1937.

(b) The following appointments were reported and approved:—

1. Mr. H. K. Wijesinghe and Mr. N. T. M. L. de Silva as Small-Holdings Propaganda Instructors from 10-8-36.
2. Mr. A. A. Silva as Clerk and Translator to the Small-Holdings Propaganda Officer from 1-10-36.

6. ACCOUNTS

(a) Statements of Receipts and Payments of the Board and of the London Advisory Committee for the Quarter ended 30th June, 1936, were approved.

(b) Dartonfield and Nivitigalakele Accounts for May and June, 1936 were tabled.

7. PUBLICATIONS

The Annual Report for 1935 was tabled.

8. TRAVELLING EXPENSES OF BOARD MEMBERS

Decided that members of the Board should receive mileage rates for attendance at meetings and on account of other services rendered on behalf of the Board at the rate of 25 cents per mile so travelled, irrespective of the mode of travelling.

RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirty-fifth meeting of the Board of Management held in the Committee Room of the Ceylon Chamber of Commerce, Colombo, at 10 a.m. on Thursday, the 12th November, 1936.

Present.—Mr. E. Rodrigo, C.C.S. (in the chair), Mr. C. H. Collins, C.C.S. (Deputy Financial Secretary), Messrs. I. L. Cameron, L.M.M. Dias, L. B. de Mel, J.P., U.P.M., Col. T. G. Jayewardene, V.D., Messrs. J. C. Kelly, F. A. Obeyesekere, J. L. D. Peiris, C. A. Pereria, B. M. Selwyn and Col. T. Y. Wright.

Mr. T. E. H. O'Brien, Director, was also present by invitation.

Apologies for absence were received from Messrs F. H. Griffith, M.S.C., R. C. Kannangara, M.S.C. and Mr. E. C. Villiers, M.S.C.

1. MINUTES

Draft minutes of the thirty-fourth meeting which had been circulated to Members were confirmed and signed by the Chairman.

MATTERS ARISING FROM THE MINUTES

(a) *Application for Grant from the Department of Industries.*—A letter from the Minister for Labour, Industry and Commerce, informing the Board, of the conditions on which a grant for the purchase of machinery would be recommended, was considered and the terms of reply decided on.

(b) *Report of Sub-Committee on Terms of Service of Officers Recruited from Abroad.*—The report which had previously been circulated to Members, was approved after discussion. A vote of thanks to the Sub-Committee was adopted.

2. BOARD MEMBERSHIP

The Chairman reported that Mr. F. H. Griffith, M.S.C., had been renominated by the Planters' Association of Ceylon as one of its representatives on the Board for a further term of 3 years from 15-11-36.

3. DECISION BY CIRCULATION OF PAPERS

Manuring at Dartonfield.—The Chairman stated that a recommendation of the Experimental Committee to complete the manuring of the estate in the current year, had been submitted to Board Members for approval by circulation of papers, but a Member had asked for the matter to be postponed for decision at a meeting. After discussion it was decided to postpone manuring until next year in view of the difficulty of completing the programme before the feeding roots became dormant, prior to the wintering period.

4. ACCOUNTS

(a) *Estimates for 1937.*—Draft estimates which had been circulated to Members were considered in detail. After discussion the following estimates were adopted :—

Revenue			Rs. 163,760·00
Expenditure on revenue account		Rs. 135,982·00	
Expenditure on capital account :—			
Buildings	Rs. 61,000·00		
Equipment	,, 2,000·00		
Agricultural development	,, 6,072·00	,, 69,072·00	,, 205,054·00
Estimated credit balance at December 31st, 1937.			Rs. 49,616·00

(b) Dartonfield and Nivitigalakele accounts for July and August, 1936 were tabled.

5. STAFF

(a) *Director's Service Agreement.*—Decided to have agreement drafted on the basis of the terms adopted earlier in the meeting.

(b) *Renewal of Agreement of Botanist and Mycologist.*—Decided to offer re-engagement to Mr. R. K. S. Murray on the basis of the terms adopted earlier in the meeting.

(c) *Leave for Botanist and Mycologist.*—Application from Mr. R. K. S. Murray to proceed on home leave on January 20th, 1937 was approved.

6. EXPERIMENTAL COMMITTEE

RECOMMENDATIONS MADE AT MEETING OF 13TH OCTOBER

(a) *Visiting Agent's Report.*—Report Adopted.

(b) *Price of Manufactured Goods.*—A recommendation regarding the price at which vulcanized goods manufactured at Dartonfield should be sold, was considered. The Director was asked to submit a list of products available in addition to rubber tubing.

7. TECHNICAL OFFICERS' REPORTS FOR 1ST, 2ND & 3RD QUARTERS 1936

The Chairman expressed regret that the reports had not been submitted for consideration earlier and said that future reports would be brought before the Board as soon as available. Attention was drawn to the fact that there had been a confusion of clones in a plot of the 1935 replanted area. It was noted that the matter had been fully investigated and the error traced to 2 or 3 plants which were budded when the clone was originally introduced at Nivitigalakele.

The reports were adopted.

8 RUBBER COUPONS

It was decided that surplus coupons should be sold before the end of the year.

The meeting closed with a vote of thanks to the Ceylon Chamber of Commerce for the use of the Committee Room.

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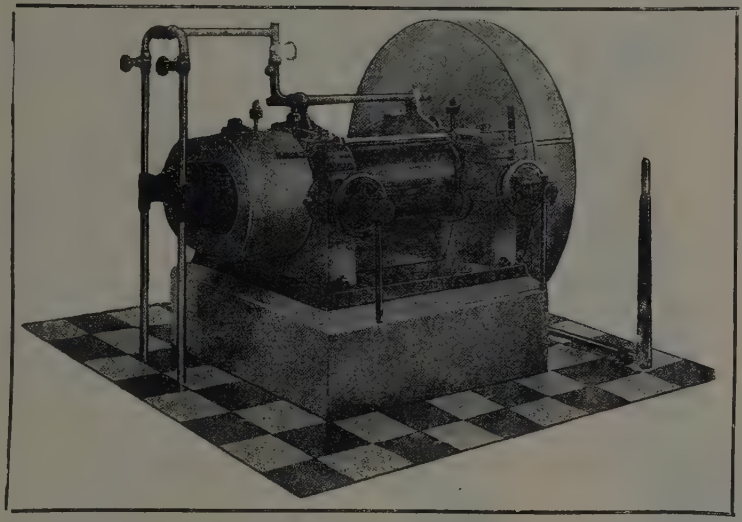

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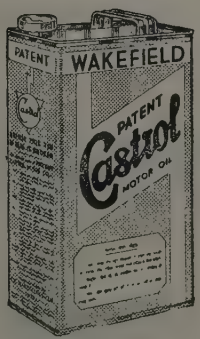

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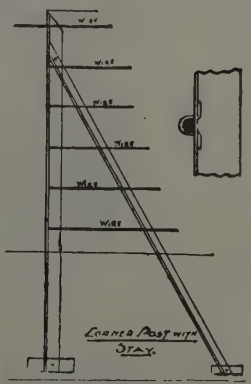

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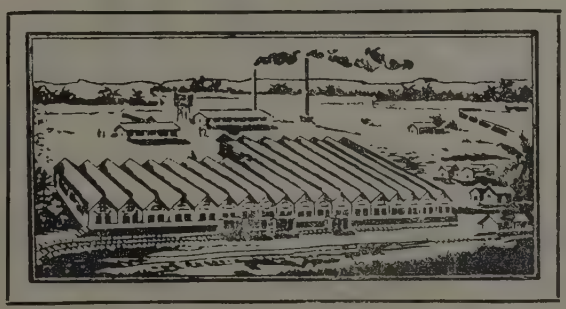

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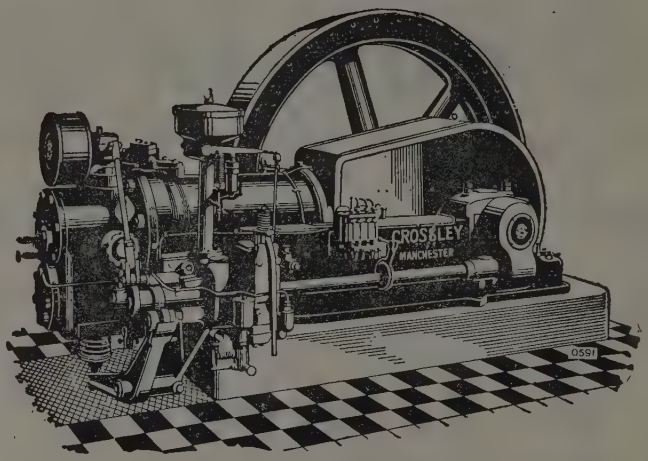

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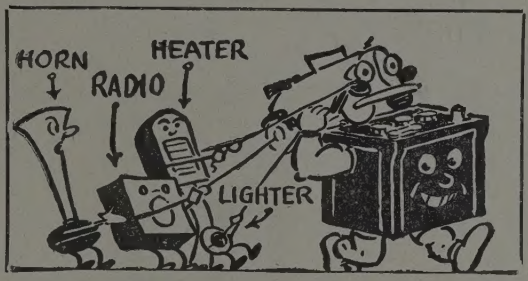

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Booklets at Rs. 2-50 per copy.

Guide to the Preparation of Plantation Rubber, by T. E. H. O'Brien, M.Sc., A.I.C., Chemist.

The Budding of Rubber, by R. A. Taylor, B.Sc., Physiological Botanist. (out of date).

Diseases of Rubber in Ceylon, by R. K. S. Murray, A.R.C.Sc., Mycologist.

Copies of the following publications of the Rubber Research Institute of Malaya are available at the prices indicated:—

Planting Manual No. 4—Latex Preservation and Shipment **Rs. 3-50.**

Planting Manual No. 5—The History and Description of Clones of *Hevea Braziliensis*. **Rs. 5-00.**